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SELECTED PAPERS FROM
ICOM'01, ICOM'05 AND
ICOM'08

Editors

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The Use of Scanning Electron Microscope in Evaluating Insulation Property

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ABSTRACT

This paper introduces the use of a scanning electron microscope (SEM) to evaluate the insulation property of insulators. An SEM may be used not only to observe a surface image but also to provide a fine electron beam for charging an uncoated-insulator surface at once. The distribution of electric field created by the surface charging can be developed by a simple model. The increase of electric field at the surface may exceed a critical value when a surface breakdown/flashover occurs. An insulation property is evaluated by varying the extended period of charging/electron bombardment which is needed to initiate a treeing-formation (hereinafter time to flashover treeing/TTF). In this paper, under a certain SEM's energy and magnification, SiO₂ addition into a high purity MgO has resulted in different TTF. Therefore, this method can be used to evaluate the insulation property of insulators which are exposed in electron beam environment.

1. INTRODUCTION

The ability of insulators to withstand a high voltage is of great importance knowledge in modern technology. The phenomenon involves surface charging, discharging and flashover (dielectric breakdown), resulting the instrument damage and material degradation. Flashover phenomenon has been studied for many years and it is believed that a flashover is initiated from triple junction of metal, insulator and vacuum [1]. A number of experimental [2,3] and theoretical works [4,5] stressed the leading role of the surface charge accumulation on the flashover. Electron bombardment is often used to make charge accumulation on the surface of insulator. Electrons produced in an SEM are possible to be controlled in their parameters: the implantation depth and the dose rate by adjusting, respectively, the primary beam energy E_0 and the primary beam current I_0 .

The use of an SEM for investigating surface charging and discharging was reported [4]. Subsequent breakdown has been observed by measuring secondary electron and specimen current. It should be emphasized that breakdown is confined near the dielectric (subsurface) and is not dielectric to metal or metal to metal. The incubation of an accumulated charge at submerged layer until occurring discharge (breakdown) was used to evaluate insulation property in space craft dielectrics (i.e. Kapton, Milar, and Teflon).

Later, another group [5] observed optically-visible flashover (tree like structure) when a wide-band-gap polycrystalline Y₂O₃ sample was first charged with a beam of 30 keV and then discharged with a low beam energy of 3 keV. The accepted idea of this observation is that the flashover is due to the space charge destabilization under low energy electron irradiation. So far, the use of an SEM is limited to find a simple explanation of charging and discharging process on